# Contents

Molecular Beam Epitaxy for the Formation of Nanostructures .................. 1

*H Sakaki*

1 Introduction 1
2 Abruptness and flatness of interfaces 1
3 Impurities and mobility in doped heterostructures 10
4 Growth of laterally defined structures 14

Lateral Patterning of Nanostructures ........................................... 21

*H G Craighead*

1 Introduction 21
2 Overview of lithography 22
3 Photon lithography 23
4 Electron beam lithography 24
5 Ion Beams 26
6 Pattern transfer 27
7 Conclusion and Discussion 28

Theory of Electrons in Low-Dimensional Systems ............................. 31

*F Stern*

1 Introduction 31
2 Electron states in low-dimensional systems 33
3 Screening 35
4 Bound states 37
5 Charge transfer 38
6 Transport in heterolayers 41
7 Modelling of confined electrons 46
8 Parabolic potentials 49

Hole Eigenstates in Semiconductor Heterostructures .......................... 53

*G Bastard*

1 Introduction 53
2 Valence bands in low-dimensional systems 54
3 Optical properties 57
4 Quantum wires 58
5 Polarisation effects in quantum wires 60
# Theory of Coherent Quantum Transport

**A D Stone**

1. Introduction ................................................................. 65
2. Landauer-Büttiker approach to transport .......................... 70
3. Physical consequences of the LB formula ....................... 74
4. Impurity-average technique in real space ....................... 80
5. Average Green function in SCBA ...................................... 83
6. Cooperon correlator ....................................................... 90
7. Weak localisation magnetoresistance ............................... 91
8. Universal conductance fluctuations ................................. 94
9. Summary and conclusions ............................................... 98

# Is Atomically Precise Lithography Necessary for Nanoelectronics?

**G Timp**

1. Introduction ................................................................. 101
2. Transport in an electron waveguide ................................. 102
3. Manipulating an atomic beam with light ......................... 120
4. Conclusions ................................................................. 125

# Semiclassical Motion in Periodic Potentials and Non-local Resistance

**P Main**

1. Semiclassical motion in periodic potentials .................... 129
2. Non-local resistance ....................................................... 137

# Double Barrier Resonant Tunnelling Devices With Lateral Gates

**L Eaves**

1. Introduction ................................................................. 149
2. Structure and overall form of $I(V)$ ............................... 150
3. Sub-threshold structure in $I(V)$ .................................... 150
4. Asymmetry of $I(V)$ at high negative gate bias ............... 156
5. Conclusion ................................................................. 159

# Mesoscopic Localised Transport

**A B Fowler**

1. Introduction ................................................................. 163
2. Fluctuations in hopping conduction ............................... 163
3. Resonant tunnelling ...................................................... 168
### Charge Quantisation Effects in Small Tunnel Junctions

**L J Geerligs**

1. Introduction 171
2. Basic theory 174
3. Effects of the electromagnetic environment 181
4. Devices 185
5. Superconducting junctions 193
6. Semiconductor systems 199

### Spectroscopy of Semiconductor Nanostructures

**C M Sotomayor Torres**

1. Introduction 205
2. Survey of some optical techniques 206
3. Optical assessment of dry etching 208
4. One-dimensional geometrical effects 212
5. Luminescence from free-standing dots 215
6. Luminescence from GaAs-AlGaAs wires 218
7. Models governing the emission yield of nanostructures 220
8. Annealing and overgrowth of nanostructures 222
9. Conclusions 225

### Collective and Single-Particle Excitations in Low-Dimensional Systems

**D Heitmann**

1. Introduction 229
2. Volume and surface plasmons 230
3. Two-dimensional electronic systems 235
4. Two-dimensional plasmons 236
5. Inter-subband resonances in a 2DES 238
6. Systems with modulated charge density 240
7. One-dimensional electronic systems 242
8. One-dimensional plasmons 247
9. Quantum dots 249
10. Summary 253

### Experiments on Lateral Superlattices

**W Hansen**

1. Introduction 257
2. Fabrication of superlattices 258
3. Electron density superlattices 263
4. Quasi-one-dimensional electron channels in tight binding superlattices 273
5. Electrons in quasi-zero-dimensional discs 284
6. Coupled electron discs and antidots 292
7. Summary 297
Selected contributed papers

Optical Properties of Type I and Type II Nanostructures .................. 301
K Brunner, F Hirler, G Abstreiter, G Böhm, G Tränkle, and G Weimann

Planar Coupled Electron Waveguides .................................. 309
C C Eugster and J A del Alamo

Fabrication of Three-Dimensional Superlattices of Nanostructures ...... 317
V Bogomolov, Y Kumzerov, and S Romanov

Titles of contributed papers ............................................ 323

List of participants ...................................................... 327

Index ................................................................. 333